CLAIMS

1. An optical information recording method of recording information in an optical recording medium at constant linear density, in which optical recording medium that is rotated at a constant angular speed a mark is recorded by reversible phase change that is caused by irradiating a laser beam driven by a pulse that is intensity modulated in sync with a basic clock, the period of which varies in inverse proportion to a moving speed at a position in a radius direction by forming marks having different lengths by repeating a mark recording period that includes a heating power period during which the optical recording medium is fused, and a cooling power period during which the optical recording medium is cooled, the mark recording period being included in an irradiation period of the laser beam, comprising the step of:

forming a mark having a length equivalent to an even number times the basic clock period, and a mark having a length equivalent to an odd number times the basic clock period, the odd number being greater than the even number by one, by the laser beam that contains a common predetermined number of

mark recording periods that include a first mark recording period, a second last mark recording period, and a last mark recording period; wherein

the mark having the length equivalent to an even number times the basic clock period is formed by irradiating the laser beam driven by a pulse train generated with a period twice the basic clock period during the mark recording periods contained in the laser beam except the last mark recording period in sync with the basic clock, and

the mark having the length equivalent to the odd number times the basic clock period is formed by irradiating the laser beam driven by a pulse train in sync with the basic clock, wherein

the first mark recording period of the mark recording periods contained in the laser beam is delayed by a first time with reference to the first mark recording period for forming the mark having the length equivalent to the even number times the basic clock period,

the first mark recording period and the second last mark recording period are generated with a period greater by a predetermined amount than twice the basic clock period, and

other mark recording periods are generated

with a period twice the basic clock period.

2. The optical information recording method as claimed in claim 1, wherein

the first mark recording period and the second last mark recording period are made longer than twice the basic clock period by a second time and a third time, respectively, when forming a mark having a length equivalent to an odd number times the basic clock period, where the odd number is 7 or greater.

3. The optical information recording method as claimed in claim 1, wherein

the first mark recording period is made longer than twice the basic clock period by a second time and a third time, respectively, when forming a mark having a length equivalent to 5 times the basic clock period.

4. The optical information recording method as claimed in claim 2 or claim 3, wherein

the second time and the third time are the same.

5. The optical information recording method as claimed in claim 1, wherein

a length of the cooling power period of the last mark recording period is set to a fourth time.

6. The optical information recording method as claimed in claim 1, wherein

the first time is normalized by the basic clock period, and

the normalized first time is increased according to the moving speed.

7. The optical information recording method as claimed in claim 2 or claim 3, wherein

the second time and the third time are normalized by the basic clock period, and

the normalized second time and the normalized third time are increased according to the moving speed.

8. The optical information recording method as claimed in claim 5, wherein

the fourth time is normalized by the basic clock period, and

the normalized fourth time is decreased according to the moving speed.

9. The optical information recording method as claimed in claim 1, wherein

the heating power period of each of the mark recording periods is normalized by the basic clock period, and

the normalized heating power period is increased according to the moving speed.

10. The optical information recording method as claimed in claim 1, wherein

the laser beam includes an erasing power period for erasing a mark recorded on the optical recording medium, during which erasing power period the laser beam is irradiated at power less than the heating power period and greater than the cooling power period, and

the power during the erasing power period is decreased according to the moving speed.

11. The optical information recording method as claimed in claim 6, wherein

there is a relationship $Td1/T=\alpha 1 \times V + \beta 1$,

where T represents the basic clock period, Td1/T represents the normalized first time, V represents the moving speed, and $\alpha 1$ and $\beta 1$ are constants taking respective values,

$0.0070 <= \alpha 1 <= 0.0090$, and

$-0.05 <= \beta 1 <= 0.00$.

12. The optical information recording method as claimed in claim 7, wherein

there are relationships

$Td2/T = \alpha 3 \times V + \beta 3$ and $Td3/T = \alpha 4 \times V + \beta 4$,

where T represents the basic clock period, Td2/T and Td3/T represent the normalized second time and the normalized third time, respectively, V represents the moving speed, and $\alpha 3$, $\beta 3$, $\alpha 4$, and $\beta 4$ are constants taking respective values,

$-0.1 <= \alpha 3 <= 0.1$,

$0.2 <= \beta 3 <= 0.5$

$-0.1 <= \alpha 4 <= 0.1$, and

$0.2 <= \beta 4 <= 0.6$.

13. The optical information recording method as claimed in claim 8, wherein

there is a relationship $Toff/T = \alpha 0 \times V + \beta 0$, where T represents the basic clock period, Toff/T

represents the normalized fourth time, V presents the moving speed, and $\alpha 0$ and $\beta 0$ are constants taking respective values,

$$-0.030 <= \alpha 0 <= -0.010, \text{ and}$$

$$0.5 <= \beta 0 <= 0.8.$$

14. The optical information recording method as claimed in claim 9, wherein

there is a relationship $Tmp/T = \alpha 2 \times V + \beta 2$, where T represents the basic clock period, Tmp/T represents the normalized heating power period, V represents the moving speed, and $\alpha 2$ and $\beta 2$ are constants taking respective values,

$$0.01 <= \alpha 2 <= 0.02, \text{ and}$$

$$0.1 <= \beta 2 <= 0.3.$$

15. An optical information recording medium, on a substrate of which a recording layer that records a mark by reversible phase change is formed, the mark being recorded in constant linear density by a laser beam irradiated in sync with a basic clock, the period of which varies in inverse proportion to a moving speed at a position in a radius direction of the recording layer that is rotated at a constant angular speed, comprising:

preformatting recording conditions that are normalized by the basic clock period for forming a mark having a length equivalent to an even number times the basic clock period, and a mark having an odd number times the basic clock period, the odd number being greater than the even number by 1, with the same number of mark recording periods, each consisting of a heating power period during which the recording layer is fused, and a cooling power period during which the recording layer is cooled, the heating power periods and the cooling power period being alternately repeated in an irradiation period of the laser beam.

16. The optical information recording medium as claimed in claim 15, wherein at least one of a normalized first time, a normalized second time, and a normalized third time is preformatted as the recording conditions for forming a mark having a length equivalent to an odd number times the basic clock period by a plurality of mark recording periods that includes a first mark recording period and a second last mark recording period, wherein the first mark recording period is delayed by the first time with reference to when forming the mark having

a length equivalent to an even number times the basic clock period; the first mark recording period is made longer than twice the basic clock period by the second time; and the second last mark recording period is made longer than twice the basic clock period by the third time; the first time, the second time, and the third time being normalized by the basic clock period.

17. The optical information recording medium as claimed in claim 15, wherein

one or both a normalized fourth time and the heating power period are preformatted as the recording conditions for forming the mark having the odd number times the basic clock period, the odd number being greater than the even number by one, by a plurality of mark recording periods, the fourth time being equal to the cooling power period of the last mark recording period, wherein the fourth time and the heating power period of each mark recording period are normalized by the basic clock period.

18. The optical information recording medium as claimed in claim 16, wherein

at least one of constant pairs $\alpha 1$ and $\beta 1$;

$\alpha 3$ and $\beta 3$; and $\alpha 4$ and $\beta 4$ is preformatted as the recording conditions, where

T represents the basic clock period,

Td1/T represents the normalized first time,

Td2/T represents the normalized second time,

Td3/T represents the normalized third time,

$\alpha 1$ and $\beta 1$ are constants that linearly define Td1/T according to the moving speed,

$\alpha 3$ and $\beta 3$ are constants that linearly define Td2/T according to the moving speed, and

$\alpha 4$ and $\beta 4$ are constants that linearly define Td3/T according to the moving speed.

19. The optical information recording medium as claimed in claim 17, wherein

at least one of constant pairs $\alpha 0$ and $\beta 0$; and $\alpha 2$ and $\beta 2$ is preformatted as the recording conditions, where

T represents the basic clock period,

Toff/T represents the normalized fourth time,

Tmp/T represents the normalized heating power period,

$\alpha 0$ and $\beta 0$ are constants that linearly

define Toff/T according to the moving speed, and $\alpha 2$ and $\beta 2$ are constants that linearly define Tmp/T according to the moving speed.

20. The optical information recording medium as claimed in claim 18, wherein the constants are set as follows:

$0.0070 <= \alpha 1 <= 0.0090$

$-0.05 <= \beta 1 <= 0.00$

$-0.1 <= \alpha 3 <= 0.1$

$0.2 <= \beta 3 <= 0.5$

$-0.1 <= \alpha 4 <= 0.1$

$0.2 <= \beta 4 <= 0.6$.

21. The optical information recording medium as claimed in claim 19, wherein the constants are set as follows:

$-0.030 <= \alpha 0 <= -0.010$

$0.5 <= \beta 0 <= 0.8$

$0.01 <= \alpha 2 <= 0.02$

$0.1 <= \beta 2 <= 0.3$.

22. An information recording apparatus for forming marks having different lengths on a recording layer of a reversible phase-change type

optical information recording medium rotated at a constant speed, and recording information at constant linear density by irradiating a laser beam driven by a pulse train generated based on information preformatted in the optical information recording medium and representing predetermined data according to a moving speed at a position in a radius direction, comprising:

a wobble signal detecting unit for detecting the information preformatted in the recording layer of the optical information recording medium};

a record clock generating unit for generating a clock signal, a period of which is varied in inverse proportion to the moving speed of the position in the optical information recording medium onto which the laser beam is irradiated by a laser;

a system controller that holds a predetermined table and extracts mark formation conditions for forming the mark by comparing information contained in the predetermined table with the information detected by the wobble signal detecting unit; and

a recording pulse train generating unit

for converting the predetermined data into mark lengths by modulating and encoding the predetermined data, and for generating the pulse train based on the converted mark lengths; wherein

the recording pulse train generating unit generates the pulse train based on the converted mark length based on the mark formation conditions extracted by the system controller.

23. The information recording apparatus as claimed in claim 22, wherein

the optical information recording medium contains the constant pair that linearly define the mark formation conditions according to the moving speed as the information preformatted, and

the system controller holds a correspondence table of the constant pairs and the mark formation conditions, compares the constant pairs detected by the wobble signal detecting unit based on the period of the clock signal generated by the record clock generating unit with the correspondence table, and extracts the mark formation conditions.

24. The information recording apparatus as

claimed in claim 22, wherein

the optical information recording medium contains an identifier that discriminates the optical information recording medium, the identifier being preformatted,

the system controller holds a correspondence table of the identifier and the mark formation conditions normalized by the period of the clock signal, and extracts the normalized mark formation conditions by comparing the identifier detected by the wobble signal detecting unit with the correspondence table, and

the recording pulse train generating unit generates a pulse train according to the mark length based on the normalized mark formation conditions extracted by the system controller and the period of the clock signal generated by the record clock generating unit.

25. An information recording apparatus for forming marks having different lengths on a recording layer of a reversible phase-change type optical information recording medium rotated at a constant angular speed, and recording information at constant linear density by irradiating a laser beam

driven by a pulse train generated based on information preformatted in the optical information recording medium and representing predetermined data according to a moving speed at a position in a radius direction, comprising:

a wobble signal detecting unit for detecting the information preformatted in the recording layer of the optical information recording medium;

a record clock generating unit for generating a clock signal, a period of which is varied in inverse proportion to the moving speed of the position in the optical information recording medium onto which the laser beam is irradiated by a laser; and

a recording pulse train generating unit for converting the predetermined data into mark lengths by modulating and encoding the predetermined data, and for generating the pulse train based on the converted mark lengths; wherein

the recording pulse train generating unit extracts the mark formation conditions normalized by the period of the clock signal for forming the mark from the information detected by the wobble signal detecting unit, and generates the pulse train

according to the converted mark lengths based on the extracted normalized mark formation conditions and the period of the clock signal generated by the record clock generating unit.